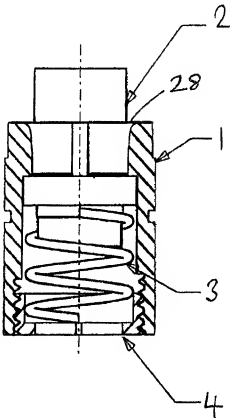


FIG.1

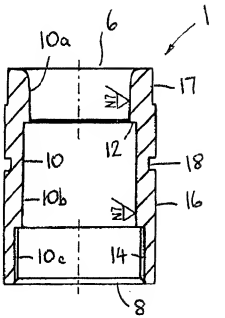


FIG.2

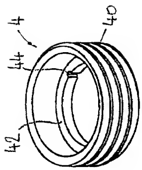


FIG. 6

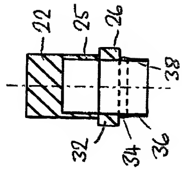


FIG. 4

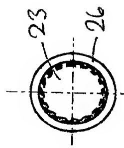


FIG. 5

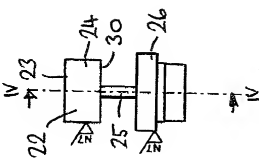
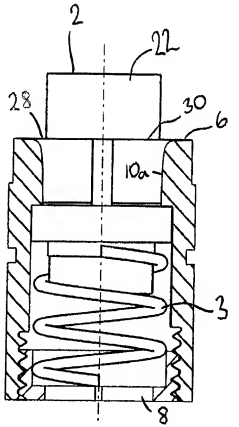
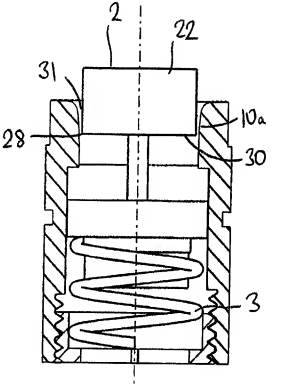


FIG. 3



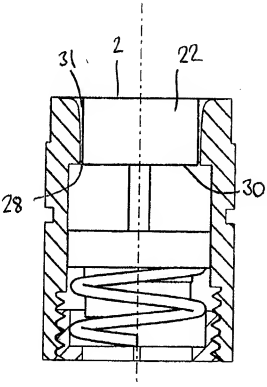
A) POSITION :- FULLY OPEN

Fig.7



B) POSITION :- INTERMEDIATE OPEN

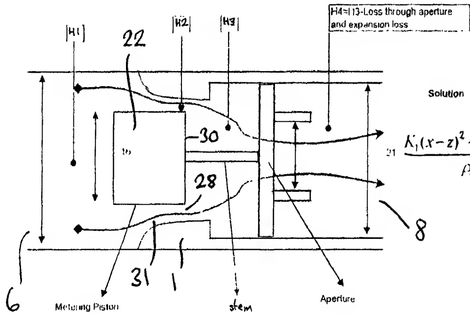
Fig.8



C) POSITION :- FULLY CLOSED

Fig.9

$$\frac{K_1(x-z)^2 + K_2(x-z)}{\rho g} = A_p(H_4 - H_3) - A_{base}(H_3 - H_4)$$



Solution

$$\frac{K_1(x-z)^2 + K_2(x-z)}{\rho g} = A_p(H_1 - H_4) - \frac{Q^2}{2gA_p^2}(A_p - A_b)(1 - \frac{A_p^2}{A_b^2})^2$$

Fig. 10

TYPICAL TRUMPET SIZES vs FLOW RATE

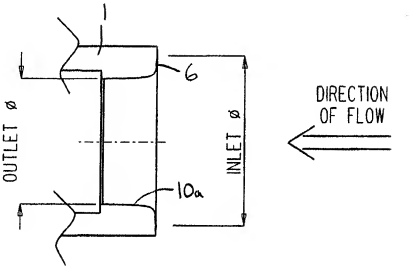


Fig. 11

SIZE	INLET DIA	OUTLET DIA	FLOW RATE l/s
3/4"	26.750	17.474	0.221
3/4"	26.626	19.059	1.199
1 1/4"	33.271	23.679	0.758
1 1/4"	31.422	24.357	1.263
2"	45.556	31.385	1.263
2"	45.575	33.343	3.157
3"	67.979	45.665	7.261

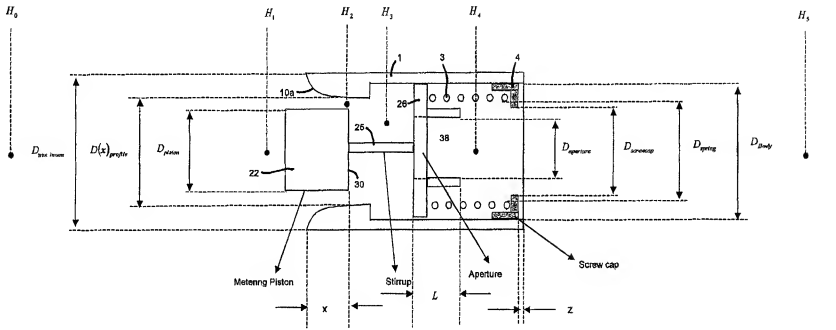

H_0
H_1
H_2
H_3
H_4
H_5
1
3
4
10a
26
25
38
22
30
$D_{bore\ house}$
$D(x)_{profile}$
D_{piston}
$D_{aperture}$
$D_{screwcap}$
D_{spring}
D_{Body}
Metering Piston
Stirrup
Aperture
Screw cap
x
L
z

FIGURE 12

Force balance

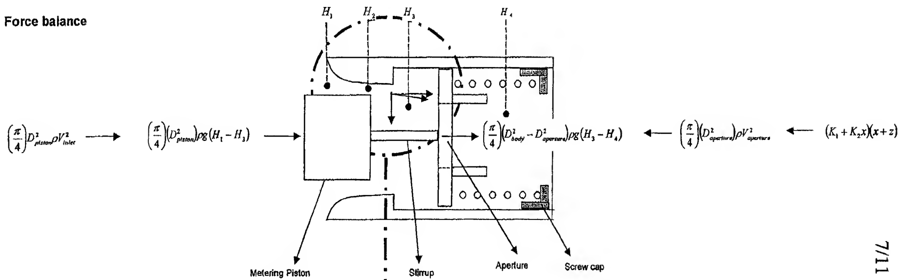


FIGURE 13

Force exerted by the emergent annular jet

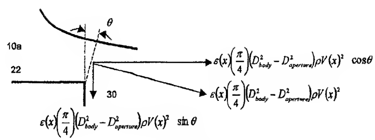


FIGURE 14

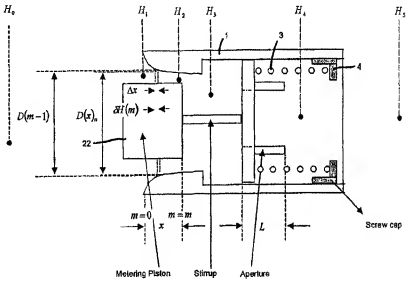


FIGURE 15

$$\delta H(m) = 0.13125\left[f(x)_n - f(m-1)\right]\frac{\Delta x_m}{\frac{\left(D(x)_n + D(m-1)\right)}{2} - D_{piston}}\ \frac{V(x)_n^2 + V^2(m-1)}{g}$$

where $f_x = \dfrac{0.25}{\left[\log\left(\dfrac{k_{profile}}{3.7\left(D(x)_{profile} - D_{piston}\right)} + \dfrac{5.74}{\mathrm{Re}(x)^{0.9}}\right)\right]^2}$ & $\mathrm{Re}(x) = \dfrac{V(x)\left(D(x)_{profile} - D_{piston}\right)}{\nu}$

$$H_1 - H_2 = \sum_{m=0}^{m} \delta H(m)$$

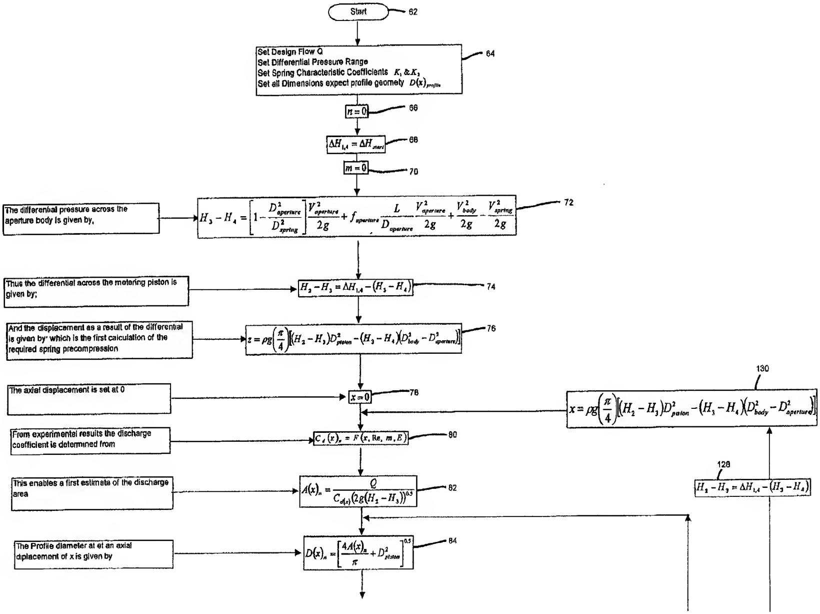
$$H_2 - H_3 = \frac{1}{2g}\left[\frac{Q}{C_d(x)\frac{\pi}{4}\left(D(x)_{profile}^2 - D_{piston}^2\right)}\right]^2$$

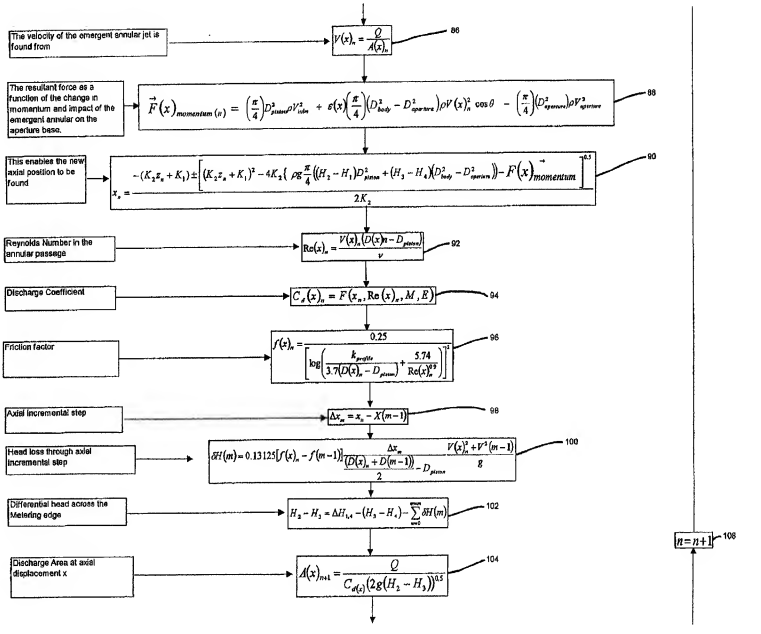
$$H_3 - H_4 = \left[1 - \frac{D_{aperture}^2}{D_{spring}^2}\right]\frac{V_{aperture}^2}{2g} + f_{aperture}\frac{L}{D_{aperture}}\frac{V_{aperture}^2}{2g} + \frac{V_{body}^2}{2g} - \frac{V_{spring}^2}{2g}$$

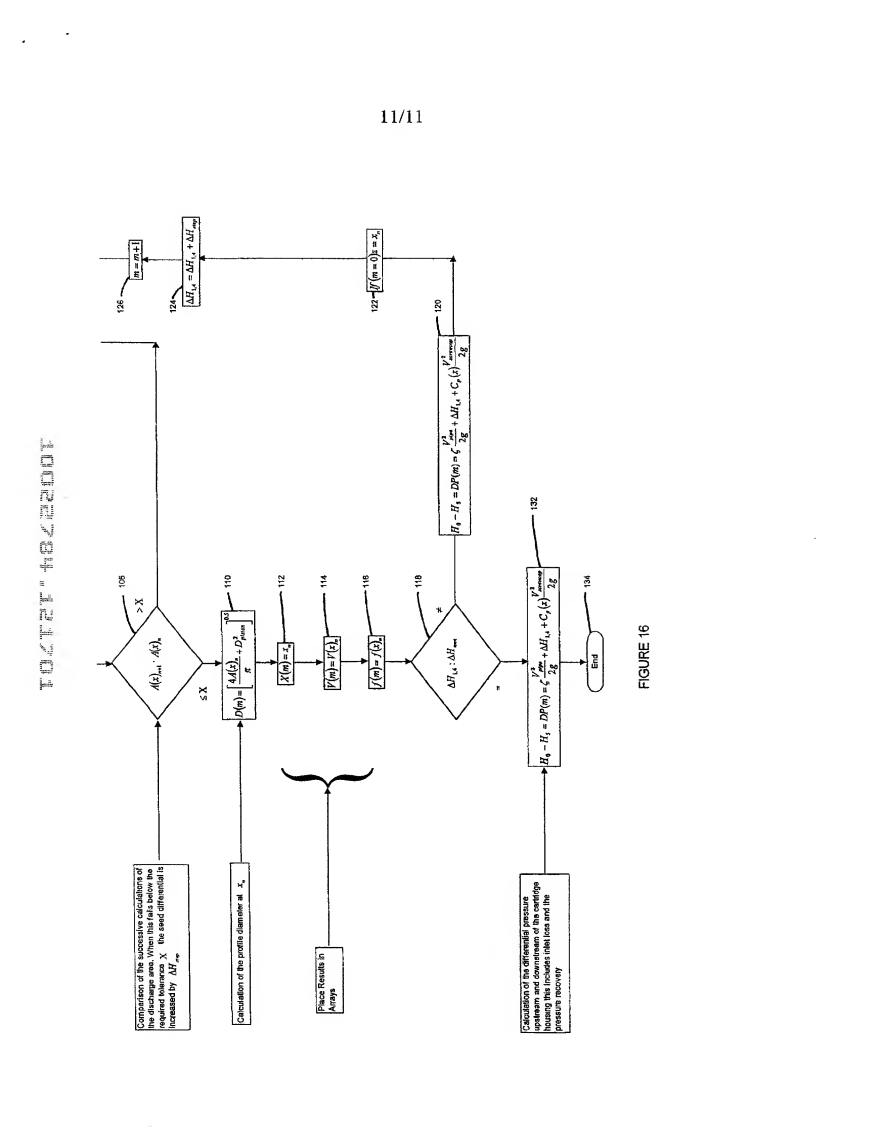
where. $f_{aperture} = \dfrac{0.25}{\left[\log\left(\dfrac{k_{aperture}}{3.7D_{aperture}} + \dfrac{5.74}{\mathrm{Re}_{aperture}^{0.9}}\right)\right]^2}$ & $\mathrm{Re}_{aperture} = \dfrac{V_{aperture}D_{aperture}}{\nu}$

$$H_5 = H_4 + C_p(x)\frac{V_{screwcap}^2}{2g}$$

$$H_0 - H_1 = \zeta\frac{V_{pipe}^2}{2g}$$


Start
62
Set Design Flow Q
Set Differential Pressure Range
Set Spring Characteristic Coefficients K_1 & K_2
Set all Dimensions expect profile geomety $D(x)_{profile}$
64
$n=0$
66
$\Delta H_{1,4} = \Delta H_{start}$
68
$m=0$
70
The differential pressure across the aperture body is given by,
$H_3 - H_4 = \left[1 - \frac{D^2_{aperture}}{D^2_{spring}}\right]\frac{V^2_{aperture}}{2g} + f_{aperture}\frac{L}{D_{aperture}}\frac{V^2_{aperture}}{2g} + \frac{V^2_{body}}{2g} - \frac{V^2_{spring}}{2g}$
72
Thus the differential across the metering piston is given by;
$H_2 - H_3 = \Delta H_{1,4} - (H_3 - H_4)$
74
And the displacement as a result of the differential is given by' which is the first calculation of the required spring precompression
$z = \rho g\left(\frac{\pi}{4}\right)\left[(H_2 - H_3)D^2_{piston} - (H_3 - H_4)(D^2_{body} - D^2_{aperture})\right]$
76
The axial displacement is set at 0
$x=0$
78
From experimental results the discharge coefficient is determined from
$C_d(x)_n = F(x, Re, m, E)$
80
This enables a first estimate of the discharge area
$A(x)_n = \frac{Q}{C_{d(x)}(2g(H_2 - H_3))^{0.5}}$
82
The Profile diameter at at an axial diplacement of x is given by
$D(x)_n = \left[\frac{4A(x)_n}{\pi} + D^2_{piston}\right]^{0.5}$
84
$x = \rho g\left(\frac{\pi}{4}\right)\left[(H_2 - H_3)D^2_{piston} - (H_3 - H_4)(D^2_{body} - D^2_{aperture})\right]$
130
$H_2 - H_3 = \Delta H_{1,4} - (H_3 - H_4)$
128


The velocity of the emergent annular jet is found from
$V(x)_n = \frac{Q}{A(x)_n}$
86
The resultant force as a function of the change in momentum and impact of the emergent annular on the aperture base.
$\vec{F}(x)_{momentum\,(n)} = \left(\frac{\pi}{4}\right)D^2_{plunger}\rho V^2_{abs} + \sigma(x)\left(\frac{\pi}{4}\right)\left(D^2_{body} - D^2_{aperture}\right)\rho V(x)^2_n \cos\theta - \left(\frac{\pi}{4}\right)\left(D^2_{aperture}\right)\rho V^2_{aperture}$
88
This enables the new axial position to be found
$x_n = \frac{-(K_2 z_n + K_1) \pm \left[(K_2 z_n + K_1)^2 - 4K_2\left(\rho g \frac{\pi}{4}\left((H_3 - H_1)D^2_{plunger} + (H_3 - H_4)(D^2_{body} - D^2_{aperture})\right) - F(x)_{momentum}\right)\right]^{0.5}}{2K_2}$
90
Reynolds Number in the annular passage
$\mathrm{Re}(x)_n = \frac{V(x)_n (D(x)n - D_{plunger})}{\nu}$
92
Discharge Coefficient
$C_d(x)_n = F(z_n, \mathrm{Re}(x)_n, M, E)$
94
Friction factor
$f(x)_n = \frac{0.25}{\left[\log\left(\frac{k_{profile}}{3.7(D(x)_n - D_{plunger})} + \frac{5.74}{\mathrm{Re}(x)_n^{0.9}}\right)\right]^2}$
96
Axial incremental step
$\Delta x_n = x_n - X(m-1)$
98
Head loss through axial incremental step
$\delta H(m) = 0.13125\left[f(x)_n - f(m-1)\right]\frac{\Delta x_n}{(D(x)_n + D(m-1)) - D_{plunger}}\frac{V(x)^2_n + V^2(m-1)}{g}$
100
Differential head across the Metering edge
$H_2 - H_3 = \Delta H_{1,4} - (H_3 - H_1) - \sum_{m=0}^{m=n} \delta H(m)$
102
Discharge Area at axial displacement x
$A(x)_{n+1} = \frac{Q}{C_{d(x)}(2g(H_2 - H_3))^{0.5}}$
104
n=n+1
106


Construction of the successive calculations of the discharge area. When this falls below the required tolerance X the seed differential is increased by
Calculation of the profile diameter at
Place Results in Arrays
Calculation of the differential pressure upstream and downstream of the cartridge housing this includes inlet loss and the pressure recovery
End
FIGURE 16